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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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20575	7590	07/29/2005		
MARGER JOHNSON & MCCOLLOM, P.C. 210 SW MORRISON STREET, SUITE 400 PORTLAND, OR 97204			EXAMINER SARKAR, ASOK K	
			ART UNIT	PAPER NUMBER
			2891	

DATE MAILED: 07/29/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/802,411

Applicant(s)

SON ET AL.

Examiner

Asok K. Sarkar

Art Unit

2891

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 16 March 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 March 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 2/14/2005.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### *Claim Objections*

1. Claims 1, 8, 13 and 20 are objected to because of the following informalities:

In claims 1, 8 and 20, in line 1, the word "metalcomprising" should be "metal comprising"

In claim 8, line 17, following "removing the", "third mask" should be "second mask".

In claim 13, lines 16 and 17, the [ ] bracket should be deleted from the sentence.

In claim 19, line 12, "forming the hole" should be changed to "forming the metal"

In claim 20, lines 18, the word "Patternas" following photoresist should be changed to "pattern as"

Appropriate correction is required.

### *Claim Rejections - 35 USC § 102*

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 8 and 10 – 12 are rejected under 35 U.S.C. 102(b) as being anticipated by Lukanc, US 6,121,149.

Regarding claim 8, Lukanc teaches a method for filling a hole with a metal comprising:

Art Unit: 2891

- successively forming an insulating layer 3 and a first mask layer 3U on a semiconductor substrate 1 (see Fig. 4);
- etching the first mask layer to form a first mask having a first opening that has a first width  $W_b$  (see Fig. 4);
- etching the insulating layer using the first mask to form a hole having the first width  $W_b$  (see Fig. 4);
- etching the first mask to form a second mask having a second opening  $W_a$  that has a second width that is greater than the first width  $w_b$  (see Fig. 4);
- forming a metal layer 5 on the insulating layer to fill the hole and the second opening (see Fig. 5); and
- removing the second mask and the metal layer to expose an upper surface of the insulating layer with reference to Fig. 1 as described in between column 11, line 4 and column 12, line 21.

Regarding claim 10, Lukanc teaches the first mask layer comprises forming a layer chosen from the group consisting of a fluorine-doped oxide layer, a carbon-doped oxide layer, a silicon-based oxide layer, a flowable oxide layer, and a methylsilsesquioxane based material (LKD) layer, and forming the second mask layer comprises forming a layer chosen from the group consisting of a SiON layer, a SiC – based material layer, a Si-based material layer, and a Si-based nitride material layer in column 10, lines 44 – 63.

Regarding claim 11, Lukanc teaches forming metal by electroplating in column 12, lines 4 – 15.

Regarding claim 12, Lukanc teaches removing the second mask and the metal layer comprises using a process chosen from the group consisting of a chemical mechanical polishing (CMP) process and an etch-back process in column 12, lines 17 – 21.

***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

6. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to

Art Unit: 2891

consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

7. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lukanc, US 6,121,149.

Lukanc teaches the parameters for the depth of the opening in column 11, lines 3 – 10, but fails to teach the thickness of the first mask layer.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control the thickness of the mask during the filling process of the hole with a metal through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

8. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lukanc, US 6,121,149 in view of Liu, US 6,010,962.

Lukanc teaches most limitations of this claim as was described earlier in rejecting claim 8. However, Lukanc fails to teach the step of forming the first photoresist pattern on the mask layer, etching the insulating layer and the mask layer using the first

Art Unit: 2891

photoresist pattern, forming a second photoresist pattern having a pattern width greater than the first width on the first mask, etching the first mask using the second photoresist pattern as a mask for exposing an upper surface of the insulating layer pattern to form a second mask having a second opening that has a second width greater than the first width.

Liu teaches the step of forming the first photoresist pattern 140 on the mask layer 130, etching the insulating layer and the mask layer using the first photoresist pattern with respect to Fig. 2A and forming a second photoresist pattern 150 having a pattern width greater than the first width on the first mask, etching the first mask using the second photoresist pattern as a mask for exposing an upper surface of the insulating layer pattern to form a second mask having a second opening that has a second width greater than the first width with respect to Figs. 2b and 2c for the benefit of reducing the dishing problem during the CMP process in column 1, lines 6 – 10.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Lukanc and use the two photoresist patterns for etching the mask layer into two different widths for the benefit of reducing the dishing problem during the CMP process as taught by Liu in column 1, lines 6 – 10.

9. Claims 1 – 7 and 13 – 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai, US 5,712,185 in view of Lukanc, US 6,121,149.

Regarding claims 1, 7, 13 and 18, Tsai teaches a method for filling a hole with a material comprising:

- forming an insulating layer 32 on a semiconductor substrate 30 (see Fig. 3C);

Art Unit: 2891

- successively forming first 34 and second mask 36 layers on the insulating layer 32 (see Fig. 3C);
- forming a photoresist pattern 37 on the second mask layer (see Fig. 3C);
- selectively etching the first and second mask layers using the photoresist pattern as a mask to form a first mask having a first opening 38 that has a first width and a second mask having a second opening that has the first width 38, etching the first mask using an etchant, the first mask having a higher etching selectivity with respect to the etchant than the second mask, to form a third mask 34B having a third opening 38 A that has a second width that is greater than the first width 38 (see Figs. 3D and 3E);
- etching the insulating layer 32 using the second mask to form a hole having the first width (see Fig. 3D);
- forming a dielectric material 40 layer on the insulating layer to fill the hole and the third opening with the material layer; and
- removing the third mask 34B and the material layer to expose an upper surface of the insulating layer (see Figs. 3H and 3I) in between column 2, line 33 and column 3, line 65.

Tsai teaches filling a whole in a semiconductor substrate with a dielectric material, and the method he teaches applies a planarization and etchback processes and other processes following the planarization that result in a smoother surface as well as free of other defects in column 3, lines 51 – 65, but fails to teach filling the whole with a “metal” layer in stead of the dielectric layer



Art Unit: 2891

Lukanc teaches a method of filling a via with a metal that requires the planarization and other etch back processes in column 12, lines 4 – 29 for the benefit of producing a void free fill of high aspect ratio recesses that are common in dual damascene processes in column 12, lines 23 – 25.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Tsai and apply the same method in filling a void created inside an insulator with a “metal” that applies the same planarization and etchback processes for the benefit of producing a void free fill of high aspect ratio recesses that are common in dual damascene processes as taught by Lukanc in column 12, lines 23 – 25.

Regarding claim 2, Tsai teaches using two different material for the two masks which will inherently have different etching selectivity with respect to the etchant.

Regarding claim 3, Tsai in view of Lukanc, fails to teach the thickness of the first mask layer.

However, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control the thickness of the mask during the filling process of the hole with a metal through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in

Art Unit: 2891

a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

Regarding claims 4 and 14, Tsai teaches the first mask as nitride and the second mask as being a Si – based material. Lukanc teaches the method of using two mask materials one being the oxide – based and the other being the nitride – based.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to modify Tsai and use an oxide – based material for the first mask since the two materials will have different selectivity with respect to a specific etchant for the benefit of forming an undercut layer in the first mask during the specific etching process.

Regarding claims 5 and 19, Tsai teaches removing the second mask prior to forming the material within the hole in column 3, lines 33 – 35.

Regarding claim 15, Tsai in view of Lukanc teaches dry etching, but fails to teach HF – based wet etchant. However, it would have been obvious to one with ordinary skill in the art at the time of the invention to use HF – based wet etchant if the masking layers are silicon oxide based materials and is well known in the art.

Regarding claims 6 and 13, Lukanc teaches forming copper by electroplating as was discussed earlier in rejecting claim 11

10. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over Tsai, US 5,712,185 in view of Lukanc, US 6,121,149 as applied to claim 16 above, and further in view of Mayer, US 6,402,923.

Tsai in view of Lukanc, fails to teach the composition of the electroplating solution comprising the acids, suppressor and accelerators.

Mayer teaches a process of using electrolytic bath containing the acids, suppressor and accelerators and their quantities in column 6, lines 21 – 60.

Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention to judiciously adjust and control these additives during the copper electroplating process through routine experimentation and optimization to achieve optimum benefits (see MPEP 2144.05) and it would not yield any unexpected results.

Note that the specification contains no disclosure of either the critical nature of the claimed processes or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen methods or upon another variable recited in a claim, the Applicant must show that the chosen methods or variables are critical (*Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir., 1990)). See also *In re Aller, Lacey and Hall* (10 USPQ 233 – 237).

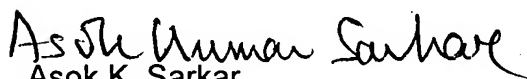
### ***Conclusion***

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Asok K. Sarkar whose telephone number is 571 272 1970. The examiner can normally be reached on Monday - Friday (8 AM- 5 PM).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William B. Baumeister can be reached on 571 272 1722. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Art Unit: 2891

12. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Asok K. Sarkar

July 27, 2005

Primary Examiner